1
The Environment in the Period of the Evolution and Diffusion of the Human Species

1.1 The Environment

Ecology is the science that essentially studies our relations with the environment (see *Note 1.1*). '**Environment**' encompasses all the living things (other than human) and the physical surroundings, which we often call nature. In the very early times, for a span of nearly two million years, during which our ancestors belonging to the earliest human species originated in Africa and spread over Eurasia, virgin nature (that is, nature unaffected by human activity) remained absolutely supreme. And this continued to be the case even after our own species, the *Homo sapiens sapiens*, the Anatomically Modern Man, appeared in Africa and initially dispersed over the whole world, within the last 150,000 years. But when the Neolithic revolution took place, and humans began to cultivate the soil and domesticate animals (see Chapter 2), they began unknowingly to change, step by step, many parts of the natural environment in which they lived. Then, with the coming of modern times, with the rise of industry, and with the use of fossil fuels and the dreadful weaponry (from gunpowder to nuclear arms), man became a visibly critical factor in the shaping of the physical environment. He is now called upon to undo, for his own good, some of what he has himself done to nature—through the destruction of forests and wild life, and the accelerating pollution of the air and water.

1.2 Physical Changes during the Pleistocene

In this sub-chapter we shall be concerned with how much **physical** circumstances varied during the geological age of Pleistocene, which extended for nearly two million years: from about 1.9 or 1.8 million years ago (the time of the 'Olduvai event', marking a change to normalcy in magnetic polarity) to about 10,000 years ago (when our current Interglacial, the Holocene, began). At the beginning of the Pleistocene age, the *Homo habilis* and the *Homo erectus*, the earliest humans, appeared in Africa, and then, finding their way out of that continent, settled in different parts of Eurasia. By the time the Pleistocene closed, our own modern human species had long supplanted all the earlier human species or sub-species in Africa and Eurasia, and also established itself, without meeting any rivals, in Australia and the New World.

By the beginning of the Pleistocene, the long period when the surface of the earth had been changed by the Continental Drift (under which India had separated from a vast continent called 'Gondwanaland', that contained, besides India, what are now Australia, Africa, Antarctica and South America) was practically over, and so were the great physical uplifts through tectonic stresses which, among other things, had created the Himalayas. By and large, it could be said that the physical features of the earth's surface had, by 2 million years ago, largely assumed a shape that we can recognize from our current maps. Yet, there continued to be some uplift, and also some erosion, and some deposition of boulder, loess and silt cut away from higher mountains, as, for example, in the Himalayas and the Siwaliks. It is even argued that during the last 14 million years the Himalayas have, in the net, been undergoing some subsidence rather than uplift. River courses and coastlines too have shifted.

Much of this change was related not only to continuing tectonic stresses, but also to immense climatic changes. The main source of the recurring changes in climate is believed to lie in the earth's relationship to the sun. The earth draws energy from the sun through receiving sun rays ('insolation'). The amount of insolation received varies not only because of the earth's own rotation, that creates day and night, but also because the earth, in its annual orbit around the sun, does not maintain the same distance from the sun, and because the tilt of the earth's axis (at an angle of 23°27) away from perpendicular to the plane of its orbit creates seasons during the year. A stable regime may appear to prevail in terms of single human generations when days lengthen and shorten, and temperatures rise and fall, with seasonal regularity. But over long periods things could change if (a) the orbit of the earth around

the sun changes its path; (b) the 'obliquity' or tilt of the earth's axis in relation to the plane of its orbit around the sun becomes greater or less; and (c) the 'precession' or slow wobble of the earth as it spins upon its axis changes the angle of sun rays to different parts of the earth's surface. Currently, as the earth goes around the sun, its distance from it ranges from 147.1 million to 152.1 million kilometres, giving a mean of 149.6 million kilometres. If the orbit were to become circular, with the longer distance adopted as the radius, the earth would correspondingly receive less heat from the sun. It is now believed that this is approximately what has been happening in cycles of about 100,000 years each, within which over the longer period the earth tended to rotate in a more circular orbit, and so was placed on an average at a longer distance from the sun. When this happened, the earth was gripped by a long cold ('glacial') phase that is usually called an **Ice Age**. As to the tilt of the inter-polar axis, it undergoes a cycle of 41,000 years. When the tilt becomes larger, however slightly, it makes summer days still longer and winter days still shorter, thus creating warmer summers and cooler winters. The converse would happen when the tilt becomes less: in this case both the summer and the winter would be moderate, but the ice sheet may expand if it does not melt greatly in summer. Finally, the 'wobble' causes 'precession' of the equinoxes that completes a cycle in about 23,000 years, thereby inserting an additional modifying factor. There could thus be considerable climatic variations within each Ice Age and Interglacial ('warming phase'), with changes in orbit and tilt and precession exerting different kinds of influence at different times.

The nearly two million years of Pleistocene saw a number of Ice Ages, when the earth's orbit increased its average distance from the sun. In such phases, as the earth got cooler, the masses of permanent ice ('thermafrost') around the Poles became denser and expanded. The snow-cover on the high mountains (such as the Himalayas) also expanded, and the glaciers came down further and further into the valleys. Considerable evidence of the greater lengths obtained by Himalayan glaciers at such times survives in the older moraines (stones and earth deposited at their lower ends by glaciers) much below the present ones, and in marks of rock erosion by glacier action far below the point (the 'snout') where the glaciers end and turn into river streams today.

As in each Ice Age water turned into masses of snow in increasing quantities each year, rivers naturally carried smaller and smaller volumes of water to the sea, so that what the oceans lost through evaporation could not be replenished. Such net loss of water caused sea levels to fall. It is probable that within the last 400,000 years the sea level fell to 100 metres below the present one on at least four occasions (*Figure 1.1*). (It should be remembered that all the oceans being interconnected, the mean sea level remains the same throughout the world at any particular moment of time.) For about eleven times during the same period, at intervals of irregular durations, the sea level has remained at or below 75 metres beneath the current level. The times when this has happened extend to over 120,000 years, that is, to about 30 per cent of the whole period. As against this, the sea has been able to maintain its present level perhaps only thrice, accounting for just 5,600 years out of the last 400,000 years, or barely 1.5 per cent of the time. Our *Map 1.1* shows what India's coastline would have roughly looked like during the Ice Ages whenever the sea sank to 75 metres below its present level.

Coming to the **physical surfaces**, at the beginning of the Pleistocene these looked broadly similar to those existing today, partly for the simple reason that fewer than 2 million years which separate its beginning from the present time would be a minute part (about 0.04 per cent) of the total span of 4,600 million years during which the surface of the earth has formed and changed. Partly, too, it may be that as the

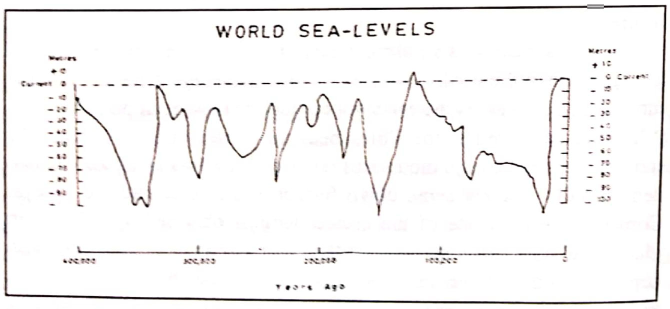
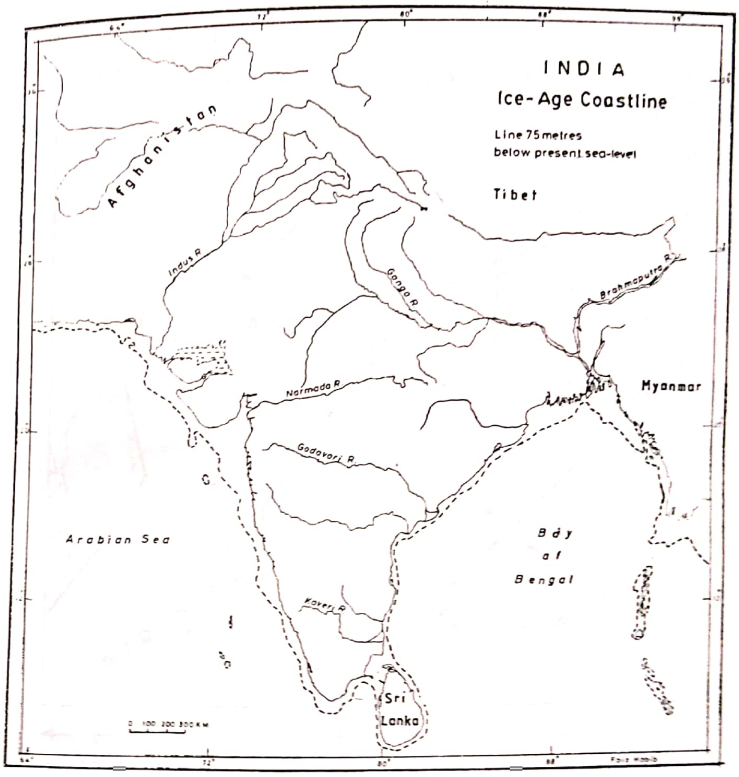


FIGURE 1.1 Sea-level changes during the last 400,000 years. Source: *National Geographic*, redrawn by Faiz Habib.

MAP 1.1 India: Ice Age Coastline, at 75 metres below present sea-level



earth cooled, physical matter at last settled, and became more and more stabilized; and partly perhaps because, after the Continental Drift reached a point of partial equilibrium, its pace slowed down greatly. Yet the tectonic stresses, though somewhat moderated, have remained a factor in forcing physical change, and some uplifts and subsidences may still be taking place. (See *Map 1.2* for the present state of tectonic stresses in areas around India).

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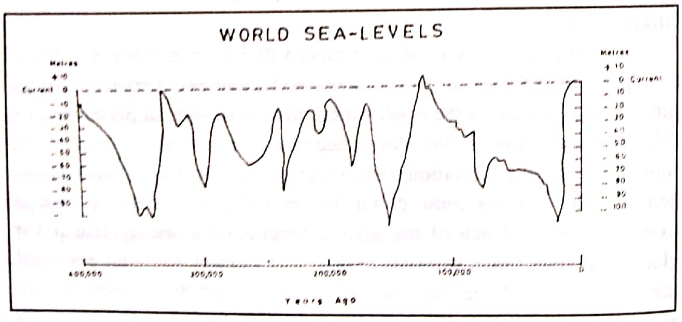

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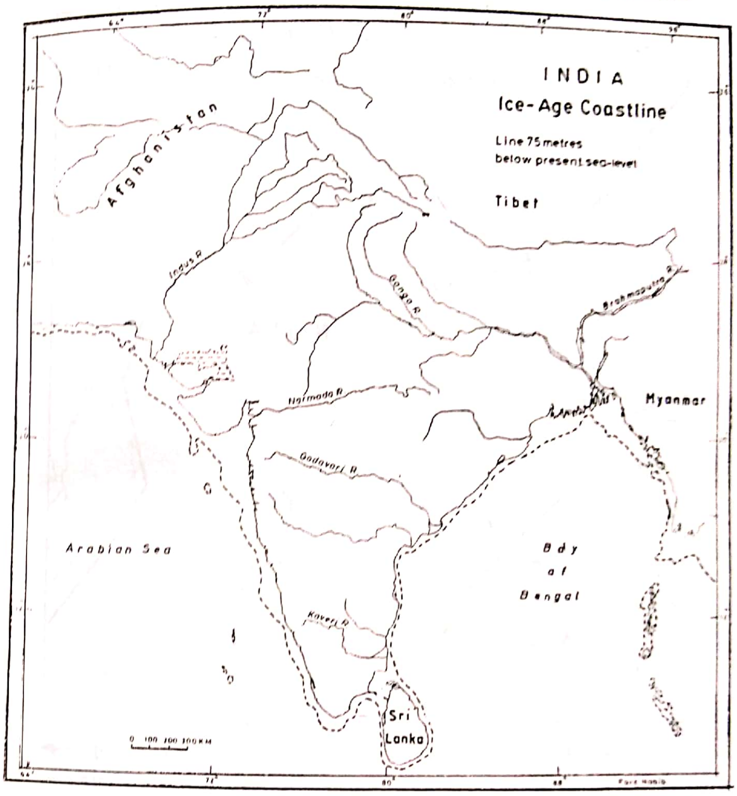

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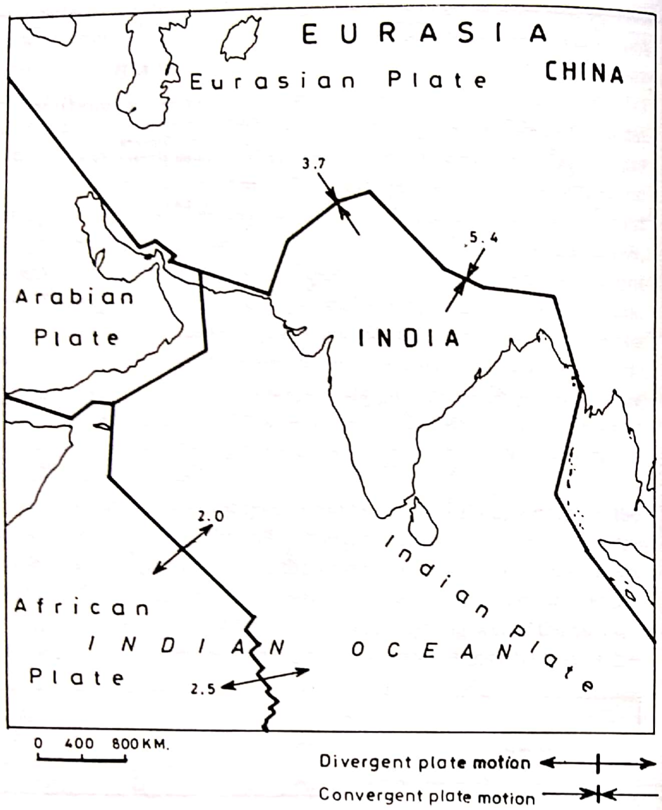
MAP 1.2 Tectonic Stresses around the Indian Plate



Note: Figures on each pair of arrows represent annual movement in cms.

altering physical contours. Masses of ice that accumulated among mountains in glaciers could, by their sheer weight, break up obstructing features and carry down huge masses of rock. A plateau undergoing tectonic lift could be converted into mountain ranges as glaciers cut their way through it. We must remember that during each Ice Age the permanent snow cover in the Himalayas expanded immensely, and glaciers

carrying large blocks of ice and rock then made their way down to areas outside the mountain ranges. Huge rocks today stand on the Potwar Plateau south of Islamabad in northwest Punjab (Pakistan), left there by glaciers moving down from the Western Himalayas.

How much the physical landscape could thus change even during the Pleistocene may be illustrated by the single case of Kashmir. There have been enough visible signs of the high floor level of a past lake for a tradition to be formed, first recorded by the Chinese pilgrim Xuan Zhuang (*c.* AD 640), that the valley of Kashmir was originally a lake (see *Extracts 1.1.A* and *B*). So indeed it was during much of the Pleistocene, when the numerous 'karewas', or 'table-lands', within the valley were created, being originally formed by the clay, sand and silt deposited on its bottom by the lake. The lake itself was fed by the Ice Age mountain snow-sheets and the glaciers coming down from them. Owing to an uplift of the valley through tectonic pressures or the gradual silting of the lake, or from both causes, the lake floor ultimately rose above the level of the Baramula gap, through which the Jhelum now flowed out and gradually drained off the entire lake. When exactly within the Pleistocene this momentous event occurred cannot apparently be determined, but it probably belongs to a late phase.

In the North Indian ('Indo-Gangetic') Plains, the alternations of Ice Ages and warm phases of the Interglacials greatly affected the volume of water and silt the rivers carried. In the Ice Ages, while the rivers (mainly those of the Ganga–Brahmaputra and the Indus systems) deposited much less silt at their mouths, the sea retreated on its own, as we have seen. When, in warmer times, the sea began to reclaim its territory as its level rose, the rivers began to carry increasing volumes of silt-laden water down to their mouths, so as to make the sea shallower near their deltas and push the land there further into the sea. In the net, however, it was the sea that greatly advanced.

There is good reason to believe that the tectonic uplifts in the Himalayas did not take place evenly, and different sections rose at different times. Such unevenness means that **river courses** in the mountains could have altered substantially, as through different degrees of uplift and subsidence, one route for a river was blocked and another opened. Much room for speculation lies here. A look at physical maps would disclose two remarkable troughs north and south of the

Himalayas. The northern one is formed, east-to-west, by the long valley of the Brahmaputra (Yalutsangpo) in Tibet, then the Manasarovar group of lakes, the uppermost section of the Sutlej, and finally, the long valley of the Indus, separating the Himalayas from the Karakoram Range at its northwestern end. This long straight trough is supposed to have been carved by a single great river (the 'Tibet River'), now extinct. The parallel southern trough is formed by the gap one finds today between the southern slopes of the Himalayas and the Siwalik ranges, that runs all the way from Assam to the Punjab with only a few breaks. If this gap was also created by a river ('the Siwalik River'), it could explain the boulders and shingle-beds which litter the Siwaliks. It is supposed that the Indus, the Sutlej and the Ganga–Brahmaputra systems captured and drained away different sections of both the 'Tibet' and 'Siwalik' rivers'. These explanations of the two great troughs are highly speculative and are no longer in favour, but apart from these hypotheses, no other suggestion given so far seems to explain adequately the curious parallel existence of the two great troughs.

Far less speculative are certain other suggestions about changes of river courses in the soft alluvial Indo-Gangetic plains. The Gangetic dolphin (*Platanista gangetica*) is found widely spread in the rivers of the Ganga–Brahmaputra system within the plains; the very same species with size slightly reduced (*P.g. minor*) is found in the Indus River system. The presence in both river systems of this riverine mammal, which is unable to move on land, could have been possible only if the Yamuna had for some time been a tributary of the Indus to enable the Gangetic dolphin to reach the Indus; or, if the dolphin originated in the Indus, then it could have reached the Ganga only if the Yamuna had once belonged to the Indus system and then begun flowing into the Ganga. The Chautang River, which rises close to the Yamuna and joins the dry Ghaggar–Hakra channel, running towards the Indus through the district of Bahawalpur, may possibly mark the Yamuna's Pleistocene course. The difference in size of the two groups of dolphins indicates that the Yamuna–Indus connection was broken up quite a long time ago but well within Pleistocene times, since the species appears still to be the same.

1.3 Pleistocene Vegetation and Animal Life

Changes in climate necessarily affected **vegetation**. In the Ice Ages, aridity grew as the rainfall became scantier and the rivers contained less and less water. Steppe and desert expanded at the expense of forest. In parts of Rajasthan and north Gujarat this is attested by the 'fossilized' sand dunes, their age revealed by the weathering and erosion undergone by them; today they stand in areas totally bereft of moving sand. Botanical evidence of Ice Age aridity comes from recent archaeological excavations at Jwalapuram in southern Andhra. It is now estimated that the last Ice Age reached its coolest temperatures around 20,000 years ago, and the sea level fell to about 110 metres below the present level. Thereafter a warming phase began, and by 10,000 years ago the sea level was just 20 metres below the present one. This change is reflected at Jwalapuram. The excavators there found in Stratum D of the site, belonging (by calibrated carbon-dates) to the period 34,000 to 20,000 years ago, evidence that suggests the dominant presence of 'grassland' (about 75 per cent); but in Stratum C, dating to 15,000 to 11,000 years ago, the share of grassland falls to 45 per cent, and the 'woodland' expands from just 25 per cent in the older Stratum D to 55 per cent in Stratum C. In other words, there was a substantial decline in aridity as the earth began to warm up after the peak of the Ice Age had passed; and woodland and forest expanded at the expense of steppe and grassland.

By the beginning of the Pleistocene, the major present groups of species in both plant and animal life had been formed. Since plants can only diffuse, in the absence of any human agency, by aid of wind and water or through the droppings of birds and herbivores, the areas where individual **plant** species flourished in the Pleistocene could have been quite limited. In these isolated areas a plant species would mutate over time into a new one, perhaps with minor adaptations. It is thus generally assumed that species of wild grasses, out of which cultivated cereals originated, were to be found in relatively small regions, from where the cultivable forms could only spread over large areas through human-managed diffusion (see Chapter 2). This could also be said of many other plants, including fruit trees: their extensive diffusion occurred only after human beings had learnt to domesticate or control them. It is therefore likely that in the warmer phases during the Pleistocene, Eurasia as a whole had many more plant species and sub-species (each with relatively small habitats) than it has today; but the same could not be said of individual regions within it. India, for example, might have had fewer plant species than now, simply because those imported into it through human agencies, deliberately or otherwise, were then absent. There is also, of course, the possibility that at each advance of the Ice Age, many species of plants in the northern latitudes were eliminated; and some, perhaps, also in the areas of desiccation at lower latitudes. This makes it still more difficult to compare the Pleistocene's plant wealth with that of even early Holocene (beginning about 10,000 years ago), in India as well as other countries.

The Pleistocene, with its cold and warm phases alternating more rapidly in the later portion of its span, that is, after 800,000 years ago, must have been both a testing time and a period of opportunity for many species of **animals**. As, during the phases of glaciation, the sea levels went down, the isolation of several large areas was broken and land animals could now migrate to them the more easily. Sri Lanka must have received elephants before the land bridge to India was closed for the last time, after 20,000 years ago; that the tiger has never been found on that island shows that it must be a late arrival in south India. Australia, which still remained isolated however much the sea fell, witnessed the evolution of a whole range of species of marsupial mammals (those carrying their young in their pouches, like the kangaroo). Marsupials maintained their monopoly over mammal wild life there until the dingo, or Australian wild dog, arrived some thousands of years ago, presumably with some groups of human immigrants. Asia, Europe and Africa, where the same or kindred mammal species could roam at will, ultimately saw the rise and spread of the numerous major mammal species of today. The drying of parts of the Bering Sea between Alaska and Siberia at peaks of the Ice Ages meant that there could be movements of some mammals of the colder climes into or out of the North American continent as well, though in the warmer regions and in South America, the local mammalian species evolved quite differently from those of the Old World: witness the *llama* of Peru, the smaller, humpless cousin of the Asian camel.

In Eurasia, all the major species of mammals took their present shape during the Pleistocene, for mammalian species generally

maintain themselves basically unchanged for 1 to 2 million years and the Pleistocene ended only about 10,000 years ago. It is also true, however, that several mammals became extinct owing to a failure to adapt to climatic changes, or through displacement by more efficient species competing for the same resources, or—towards the close of the Pleistocene—by simple slaughter at human hands.

How different animal species evolved, died and survived during the Pleistocene may be illustrated by the story of two groups of species whose subsequent domestication has been an important feature of faunal history in India, namely, the elephant and cattle.

Of elephants (*Probiscidae*), which now survive in just two species, the African and the Asian or Indian, there were a large number of species during the Pleistocene. Some seventeen extinct species have been identified from fossils found in different parts of India, including even Kashmir, dating back to the Pleistocene and the still earlier Pliocene. Many elephant species probably died out because of the aridity that the long Ice Ages created in tropical and semi-tropical lands where their natural habitats lay. One species alone, the woolly mammoth, adapted itself quite successfully to the icy-cold environment of Europe, Siberia and Northern America. Its origins are placed around 400,000 years ago. But as the last warming phase began around 15,000 years ago, and some nine-tenths of the mammoth habitat lost its snow-cover and turned warm, the animal's numbers declined heavily. Humans hunting it for its rich meat probably completed the mammoth's destruction by about 10,000 years ago. The Indian elephant, like its African counterpart, somehow survived the aridity of the Ice Ages, during which, as we suggested above, it probably reached Sri Lanka and Indonesia, making use of the transitional land bridges. Around the arrival of the Holocene, our current Interglacial, the elephant's zone of habitat in India was remarkably extensive. It was found even in the dry lands of the Indus basin: bones of an elephant killed at Mehrgarh, in the steppe-like plain below the Bolan Pass in Pakistan, were found in strata datable to 7,000 or 6,000 years ago (Mehrgarh Period II, *c.* 5000–4000 BC).

The auroch (wild ox) possibly rivalled the elephant in the number of species it had spawned. One such species was the ancestor of the modern domestic ox. The 'zebu' or humped ox (*Bos indicus*), that we in India are so familiar with, now forms an entirely domesticated sub-species of cattle. The early history of this sub-species from fossil evidence is hard to trace; but comparative DNA studies suggest that its ancestral line separated from that of the humpless taurine ox (*Bos taurus*) (common in Europe, the Middle East and West Africa) some 600,000 to a million years ago, though the zebu itself formed into a distinct sub-species much later still. The time-span has not been long enough to constitute the two sets of cattle into separate species; and the zebu can interbreed freely not only with taurine cattle, but also with the humpless gayal (*Bos frontalis*) of India and the woolly Tibetan yak (*Bos grunniens*). The zebu's special features, besides its large hump, is its capacity to fare well in warm temperatures and arid conditions, which the other sub-species of cattle do not possess. In its wild state, therefore, it was able to withstand both the aridity of the Ice Ages and the warmth of the Interglacials. Its original habitats lay within India, confined probably to the more arid parts, at the beginning of the Holocene (8000 BC).

The water buffalo (*Bos bubalus*) evolved into a separate species much earlier, within or even before the Pleistocene times, and in its wild state existed in a large portion of tropical and semi-tropical Asia, from India eastwards to southern and central China. Though now it is largely domesticated, herds of wild water buffalo still survive in dwindling pockets and are known to have had a much larger range in even Mughal times. Like the zebu, the buffalo can withstand warm temperatures, but it is particularly attracted to water and so, in the wild, keeps to riverine and marshy tracts. In late-Pleistocene India it seems to have had an extensive habitat, right up to the western edge of the Indus plains.

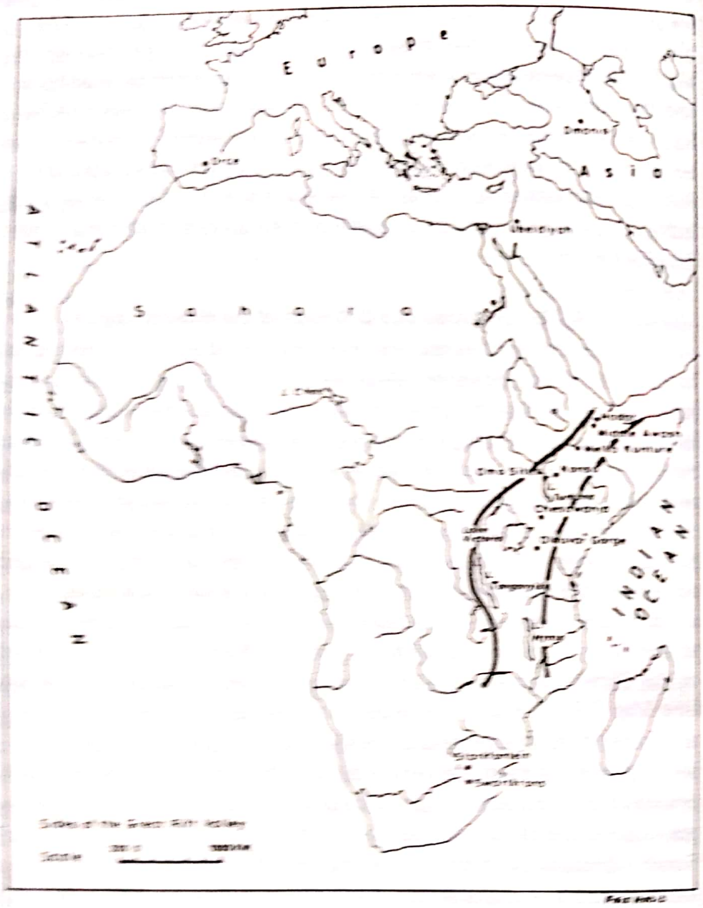
Both the elephants and the cattle species interest us because of their later relationships to us as domesticated animals (though elephants have remained in a wild state far more extensively than cattle). Yet we must remember that until the very close of the Pleistocene, there was little sign of animal domestication, and wild life was still practically unaffected by human action, except for the animal slaughter that man constantly undertook as a meat-eating animal, like any of the other carnivores. In the demise of some species of mammals present in India in Pleistocene times, man has had probably no or only a partial role to play. It has been found that many species whose fossils have been found, as in the Kurnool caves (Andhra), from different Pleistocene

phases, were more suited to humid climates, and probably died out as aridity grew during the Ice Ages; and, conversely, some which thrived on grassland could not survive when the warmer and more humid Interglacials arrived. Climatic change might thus have been partly responsible for the disappearance from India of the hippopotamus, wild horses and the spotted hyena: the first and the third now survive only in Africa. Egg-shells of the ostrich, which is also now confined to Africa, have been found at Batadomba-lena (Sri Lanka) 28,500 years ago, and at Patne (Maharasthra) as late as 24,000 years ago. For the elimination in India of this, the largest bird on earth, human hunters might have to bear the chief blame.

1.4 The Evolution and Diffusion of the Human Species

In chapter 2 of the first monograph of the People's History of India series, titled *Prehistory*, there will be found an account of the evolution of the human group of primates and the diffusion of the early humans from their original region. The *Austrolopithecines*, ape-like bipeds, arose nearly 4 million years ago, forming the 'hominid' precursors of the human species. Since their remains are found only in Africa, it is a logical assumption that their human successors originated in Africa as well. This has been fortified by the fact that the earliest remains of the first two human species, *Homo habilis* and *Homo erectus*, and their stone tools ('artefacts') have been found at a series of sites within eastern and southern Africa, many of them preceding the arrival of the Pleistocene age, which is placed around 1.8 million years ago (see *Map 1.3*). The sites are largely confined to the 'Great Rift Valley', which has been in a process of tectonic uplift within the African plate, accompanied by much volcanic activity. This rift runs from the southern tip of the Red Sea (which technically belongs to it), through Ethiopia, Kenya, Tanzania and Malawi, ending close to the great plateau of South Africa. It has been thought that this Rift Valley, with its broken hillsides and a string of savannahs (largely treeless ground) running in the middle, and containing numerous natural accumulations of water, provided the ideal environment for humans, who as yet did not know the use of fire, and had no tools beyond simple broken and chipped stones ('Oldowan tools'). Individually helpless against large predators, man could protect himself only in the company of his group hiding in

Map 1.3 Africa: Human Origins in the Great Rift Valley
(*Homo habilis* and *Homo erectus* sites)



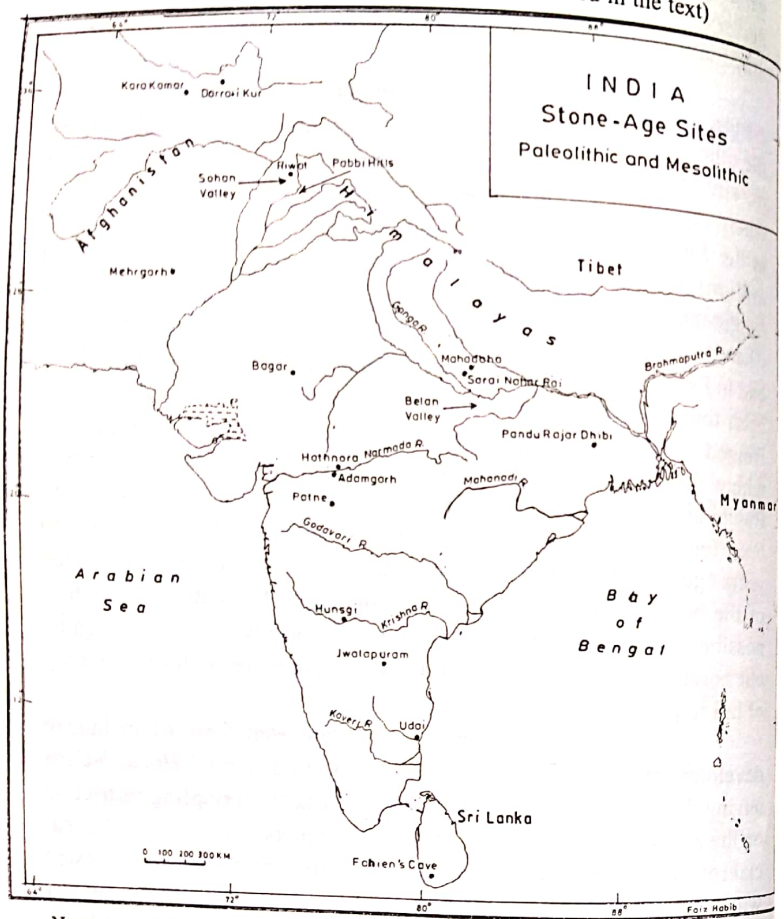
rock shelters and caves. Here, from hillside, as part-hunter and part-scavenger, he could spot predators and prey from a distance on the tree-less plain. He could also feed on savannah bush and grass containing edible fruits, roots and seeds. The African Rift Valley, which is a unique

geographical feature in the Old World, could thus provide the largest nursery possible for the human species in infancy. To this extent one may make one's bow to environmental determinism!

When the *Homo habilis* and *Homo erectus* spread outside Africa, perhaps taking advantage of the fall in sea levels during one or the other of the cooler phases, they seem to have sought, and survived in, similar (Rift Valley-like) environments as is shown by the sites where their remains have been found: Ubediya (1.4 million years ago) in the Jordan Valley, a continuation of the African Rift; Dmanisi (1.7 million) in the Caucasus mountains; and Renzidong (2.25 million!) and Longgupo (1.9 million) in the hill-fringed sections of the valley of the Changjiang (Yangzi Kiang) River in China. At Riwat, south of Islamabad in Pakistan, where Oldowan tools of about 2 million years ago have been found, a similar environment is provided by the Potwar Plateau fringed by the Salt Range in the south (*Map 1.4*). Nearby, to the east, where the Jhelum flows through a broad gorge framed by the Salt Range on its right and Pabbi Hills on its left, pebble-flake tools have been found in the Pabbi Hills, datable to between 1.6 and 0.9 million years ago. Further eastward, in the Jammu Siwaliks on the Indian side of the border, similar pebble-flake tools come from strata dated to a possibly still earlier time. In all these cases, the environment chosen by our possible ancestors is invariably one where there is close proximity of hill to plain.

It must have been an important step forward in human development when the *Homo erectus* (his smaller rival *Homo habilis* having disappeared by now) was able to break this crippling restriction on the zones of his settlement. Two developments might have had a crucial role to play in this: first, the discovery of control over fire, attested with a fair degree of probability at the east African site of Chesowanja 1.4 million years ago; and, second, the capacity attained in Africa, about the same time, of making stone 'hand-axes', the so-called 'Acheulian' tools. Fire gave man an instrument with which to clear parts of bush and forest, make meat more palatable, and scare away wild animals, while the hand-axe probably played a great part in turning him from a mere scavenger into a hunter. At last, the *Homo erectus* could move from plain-fringed hillsides into open plains and deserts. The Acheulian sites in India, as in other parts of Eurasia, are located in

Map 1.4 India: Stone Age Sites, Palaeolithic and Mesolithic
(Reference map for Stone Age sites mentioned in the text)



Note: Sohan Valley = Potwar Plateau. Mehrgarh and Pandu Rajar Dhibi are Neolithic sites.

practically all kinds of terrain, though proximity to sources of stone still remained a limiting factor. The upper limits for the date of the arrival of Acheulian tools in Sohan Valley (in Pakistan) and in Kashmir have been fixed at 700,000 years ago; but now, from Isampur in Karnataka, comes evidence of a brisk Acheulian 'industry' dated to 1.2 million

years ago, the date being obtained by ESR ('electron spin resonance') applied to bovine teeth enamel.

By 500,000 years ago, the *Homo erectus* had well passed the normal average lifetime for a species, and was breaking up into sub-species as groups became isolated from each other in different regions. One such evolved species, the Neanderthal (*Homo sapiens neanderthalensis*), especially adapted itself to colder climes (through developing a more robust frame), and has left its traces in a vast area of northern Eurasia that went under ice and snow in the later phases of the Pleistocene. The human skull discovered at Hathnora in the Narmada Valley (Madhya Pradesh in India), datable to a period earlier than 130,000 years ago, represents an evolved *Homo erectus* without apparently any Neanderthal-type features. It was out of a similarly evolved sub-species of *Homo erectus*, often called 'archaic *Homo sapiens*', that our own species, the *Homo sapiens sapiens* or Anatomically Modern Man, originated in some part of eastern or southern Africa some time around 150,000 years ago. This estimate of date is based on the archaeological evidence; the geneticists tend to put the origin of our species still earlier, nearer to 200,000 years ago.

The anatomical advantage possessed by our species lay not so much, perhaps, in the large brain-case (the Neanderthal too had an equally large one), but in gracility, that is, in the trading away, in adaptation, of sheer muscular strength for muscular manoeuvrability. It is possible that an increased capacity for speech was also one aspect of this genetical change. By this means modern man did not only improve his muscular ability to make more complex tools, but also secured through speech an efficient means of transmission of knowledge (including that of tool-making) and closer social cooperation (for example, in group hunting). He could not only make the kinds of stone tools the other human species made, such as flaked blades, hand-axes, 'Levallois–Mousterian' tools, etc., but also backed blades and, then, microliths, both of which serve as special markers of his presence for archaeologists. By 30,000 years ago, he had practically supplanted or eliminated other competing sub-species (the case of the destruction of Neanderthals in Europe being illustrative of what could have possibly happened). In India, where modern man probably arrived about 75,000 years ago, he had begun making microliths in Sri Lanka and south India by 35,000 years or so ago. This greatly aided his killing power (through sharper spears and arrows) and made possible a greater density of population within his areas of settlement. K. Paddayya has estimated that in two tracts in Karnataka (the Hungsi and Baichbal valleys), the average human population density increased from a mere one person in 2 square kilometres in Acheulian times to about five persons per kilometre in Mesolithic (= microlithic) times—a ten-fold increase. Man had now indisputably become the most dominant single species in nature.

TABLE 1.1 Chronology

	Years ago
Beginning of Geological Age of Pliocene (last age of the Tertiary 'epoch')	5 million
Period of *Homo habilis* in Africa (and outside?)	2.6 to 1.7 million
Appearance of *Homo erectus* in Africa	Over 2 million
'Oldowan' tool, Riwat (Pakistan)	2 million
Beginning of Geological Age of Pleistocene (first age of the Quaternary Era)	1.8 million
First evidence of controlled fire, Chesowanja (Kenya), and use of stone hand-axe ('Acheulian') in Africa	1.4 million
Appearance of hand-axe users in India	1.2 to 0.7 million
Ice Ages and Interglacials in Late Pleistocene	
Peak of Ice Age-1	3,40,000
Peak of Interglacial-1	3,20,000
Peak of Ice Age-2	2,60,000
Peak of Interglacial-2	2,40,000
Peak of Ice Age-3	2,30,000
Peak of Interglacial-3	2,15,000
Peak of Ice Age-4	1,85,000
Peak of Ice Age-4A	1,50,000
Peak of Interglacial-4	1,25,000
Peak of Ice Age-5	70,000

TABLE 1.1 (*continued*)

Peak of Ice Age-5A	20,000
Beginning of the present Interglacial (Holocene)	12,000 to 10,000
Anatomically Modern Man (*Homo sapiens sapiens*): species formed in Africa, by	150,000
Arrival of Modern Man in India	75,000
Earliest dates for microliths in Sri Lanka and India	35,000

Note: All dates are approximate.
The numbers suffixed to late Pleistocene Ice Ages and Interglacials are given here only for convenience of tabulation and are not so scientifically designated. Between peaks of Ice Ages 4 and 4A, as well as between peaks of Ice Ages 5 and 5A, there was no real Interglacial, only some reduction in temperatures.

Extracts 1.1
The Pleistocene Lake of Kashmir

Text A: Kalhaṇa, *Rājataraṅgiṇi*, AD 1149–50, Chapter I

25. Formerly, since the beginning of the *Kalpa*, the land in the womb of the Himalaya was filled with water, during the periods of the [first] six Manus, [that formed] the 'Lake of Sati' (*Satisaras*).

26–27. Afterwards when the present period of the [seventh] Manu *Vaivasvata* had arrived, the Prajāpatī Kashyapa caused the gods led by Druhiṇa, Upendra and Rudra to descend, caused [the demon] *Jalodbhava*, who dwelt in that [lake], to be killed and created the land known by the name of Kashmīr in the space [previously occupied by] the lake.

— Kalhaṇa, *Rājataraṅgiṇi*, translation by M. Aurel Stein, I, London, 1900, p. 6.
Note: *Kalpa* is a mythical period of time.

Text B: Francois Bernier, Letter to Monsieur de Merveilles, written from Kashmir during the summer of 1665

The histories of the ancient kings of Kachemire maintain that the whole of this country was in former times one vast lake, and that an outlet for the waters was opened by a certain pire [*pīr*], or aged saint named Kacheb [Kashyap], who miraculously cut the mountain of Baramoule [Baramula].

This account is to be met with in the abridgement of the above-mentioned histories, made by the order of Jahan Guyre [Jahāngīr, the Mughal emperor, 1605–1627], which I am now translating from the Persian. I am not certainly disposed to deny that this region was once covered with water; the same thing is reported of Thessaly and of other countries; but I cannot easily persuade myself that the opening in question was the work of man, for the mountain is very extensive and very lofty. I rather imagine that the mountain sank into some subterraneous cavern, which was disclosed by a violent earthquake not uncommon in these countries. . . .

— Francois Bernier, *Travels in the Mogul Empire*, translation by A. Constable, revised by V.A. Smith, second edition, London, 1916, pp. 393–95.

Note 1.1

Ecology

Ecology is a science of relatively recent origin. The dictionaries date the first use of this word in English to the year 1873. It is derived from the Greek word 'oikos', meaning 'house'. Since the 'house' of humankind consists of the **natural environment**, the German biologist E.H. Haeckel (1879) gave a concise definition of Ecology as the science that is concerned with 'all the relations of animals and plants to one another and to the outer world'. This definition rests on the fact that the natural environment itself consists of two broadly distinguishable sectors: the inanimate and the animate. The inanimate ('the outer world') includes the earth's structure with which Geology and Physical Geography deal, along with such physical forces as tectonic stresses, lava flows, oceanic currents, rivers, solar radiation, climate, etc. The animate (comprising all levels of 'organisms') include all plant and animal species (the 'flora and fauna' of formal usage), whose study is often described by the term 'natural history', which, however, usually excludes from its purview the human and the domesticated species (see *Note 4.1*). Ecology studies the effect of physical factors on wildlife as well as cultivated plants and domesticated animals, and the relations between the different species, but its major concern is with how the natural environment in different ways affects man, and how man, in turn, by his actions, has been impacting on different parts of the natural environment, both inanimate and animate.

The study of Ecology is compartmentalized, often but not invariably, in terms of certain physical features and phenomena. Such a compartmental unit is called an 'eco-system', which may be a lake, a tidal creek, a forest, a river basin, a mountainous zone and so on. The 'space' or territory within which human and environmental interactions are studied now tends to be called a 'landscape'. Depending on the size or area of an eco-system taken for study, a range of sciences need to be involved, such as geography, geology, chemistry, botany, zoology, medicine, anthropology and history, and such specialized sub-sciences as genetics, hydrology, climatology (on which see *Note 2.1*) and archaeology. In terms of the current conventional division of scientific fields, Ecology calls for the collaboration of a very large number of scholarly disciplines. In its short history it has necessarily been influenced by some of them more than by others: thus, in the beginning, it progressed under the wings, more or less, of Biology; later on Anthropology, especially in the USA, came to exercise considerable influence on ecological thought; and now there is a return once again, perhaps, to the dominance of Biology, shared with Chemistry.

The largest 'eco-system' with which Ecology deals is of course that of the whole 'biosphere'—the entire expanse of the earth's land, water and atmosphere, within which life is possible. The ancient understanding that light from the sun is the direct as well as indirect source of all energy on earth is still valid, despite the (relatively limited) amount of energy released from tectonic stress and earth's inner heat (via lava flows), and what is now obtained from nuclear fission. *Solar energy* sustains life by initiating what is called the *food-chain*. The chain begins when sunlight is converted by 'photosynthesis' into chemical energy, especially through the transformation of carbon dioxide and water into carbohydrates (such as sugar) by green plants. These plants are eaten by herbivorous animals (as grass by cattle), and these animals in turn are killed and eaten by carnivorous animals (such as cattle by human beings). The food-chain could be still shorter when man grows cereals and eats them. But in many cases the chain is quite long and complex: Algae are eaten by small fish which might be caught in bulk for use as manure in sugarcane fields, whose crop would ultimately be made into sugar and in that form consumed by human beings. Theoretically, a multi-stage food-chain must result in much loss of energy from the point of view of the ultimate consumer, since at each stage of the chain there is much energy that is used up by the current feeder and not transmitted to the next one.

In considering the issue of food-chains and of human use of natural resources, an ethical question is now being raised: Are human beings to be guided solely by what in their view is of advantage to them and to ignore the effects of their action on other animal species, especially wildlife? This question needs to be distinguished from the natural human curiosity in animals of all kinds that helps maintain zoos and tourist-frequented wildlife reserves. What is now set forth as an ideal is the maintenance of **biodiversity**, that is, the existence of the largest possible number of species of animals and plants within a given area. There is accordingly a greater sense now than ever before that all animal species (even the most unattractive from the human point of view) need protection from extinction, which human activity, by hunting them for food or body-parts, or destroying their habitats or cutting off their food supply, e.g. through pesticides, threatens to bring about. A school that calls its approach 'Historical Ecology' is insisting, however, that human activity has not been entirely harmful for other species, that it has enriched biodiversity in several ways in the past, and that traditional practices, especially use of fire to burn down parts of forests, have helped to invigorate plant-life through cycles of rejuvenation. It obviously overstates a case that does nevertheless merit consideration.

While compassion for other species is natural and may one day become a notable part of human ethics, one belief of what may be called Popular Ecology must be treated with much reserve. This is the belief that nature left to itself—in other words, the natural environment before man began to interfere with it—was ideally suited to the well-being of all living species, because the different species tended unconsciously to adapt themselves to each other, thereby making nature achieve a balance or 'equilibrium' in the long run. It has been well said, however, that nature in its untouched state tends towards 'chaos' rather than 'equilibrium'. Not only do carnivores attack herbivores and herbivores eat up plants, but the plants themselves are involved in a deadly competition for the same sources of sustenance. In forests the taller trees may capture all sunlight so that shorter trees placed in their shadows may wither for lack of it. There can be quite intricate conflicts of interest among different species as well. For example, when fruits envelop their seeds in laxative to increase their chance of survival on being ingested by birds or herbivores, they also can thereby cause much harm to the digestive systems of the fruit-eaters.

Another error that Ecology must guard against, especially in studies of the past, is that of putting excessive emphasis on environmental change as the main factor that has shaped human society and culture. This tendency is often called **Environmental Determinism**, which is particularly noticeable among the advocates of 'Cultural Ecology'. It is of course true that changes in natural environment might often trigger human responses of a particular kind. There is continuing debate about whether an onset of aridity in certain areas could have forced our ancestors to plant and harvest those wild grasses which had the capacity to grow into cultivable crops; or whether, conversely, the Indus Civilization collapsed because a severe phase of aridity visited the Indus basin (see Chapter 2.4). Here it may, first, be mentioned that the same kind of environmental change may call forth different human responses, depending upon the level of human consciousness and knowledge, pattern of social organization, level of economic development, etc., which factors must, therefore, also be given weight. A second phenomenon that modifies the direct role of environment in history is that of **diffusion**. Environmental pressures in a small region might have had a great role to play in bringing about the cultivation of wild cereals; but then, once agriculture was established as a source of food, it would spread, by migration of people or by simple imitation, to other areas which themselves were not affected by the environmental pressures that had operated in the original areas; nor were they possessed of the wild grasses that had been transmuted into crops. Indeed, the increasing capacity for rapid diffusion may well be regarded as a particular mark of developed cultures, and this has little to do with any pressure from changes in the natural environment.

In the last thirty years Ecology has been much concerned with water and air **pollution** from industrial waste, and, leading from this, with **climate change**. Human action is bringing about a great change in nature, at the level of localities, where pollution affects lives of whole communities, and also, as we increasingly realize, in the whole biosphere. We live in the geological period of Holocene, during which, from shifts in its orbit around the sun, the earth is undergoing a warm phase. But industrial activity during the last two hundred years or so has provided a powerful additional source of warming. This is because, to put it shortly, more and more of solar heat is being trapped by greater and greater emissions of carbon dioxide (CO_2) from factories and motor cars. These emissions are essentially caused by the release of fossil fuels (coal ash, other burnt matter, gas, petroleum) into the atmosphere, while the surface absorption of CO_2 by green plants is being reduced owing to extensive deforestation worldwide. It is estimated that before the British industrial revolution of the eighteenth century, CO_2 formed only 280 parts per million in the atmosphere. It has now (in 2009) reached the level of 380 parts per million, and as a result there has been a distinct rise in world temperatures since about 1950, but accelerating noticeably after 1970. The accumulation of CO_2, even if it stays as it is, could cause alterations in rainfall regimes, the melting of polar and Himalayan ice-sheets and a rise in sea-level in future years. Mainly, it is the industrialized West that has been responsible for the bulk of the past additional accumulation of CO_2 in the atmosphere. It is, however, most doubtful if western countries are prepared to meet their share of responsibility for the dire consequences of warming for poor countries like Bangladesh, which has contributed only infinitesimally to the increase in CO_2 but may lose much of its territory to rising sea-waters. This reminds us that Ecology cannot be restricted simply to studying physical phenomena, but must also examine how particular human societies and, in the world today, the dominant powers, respond to nature's challenges, and try to shape circumstances to suit their own interests. This will be seen particularly in our Chapter 5, where we deal with Ecology during the period of colonialism.

Note 1.2

Bibliographical Note

The geographical background for the study of Indian environment is best furnished by the comprehensive work of O.K.H. Spate and A.T.A. Learmonth, *India and Pakistan: A General and Regional Geography*, London, 1967. In considering its coverage, it should be remembered that Bangladesh had not yet separated from Pakistan. There is also a separate chapter in it on Sri Lanka (Ceylon) by B.H. Farmer. S.M. Mathur, *Physical Geology of India*, National Book Trust, New Delhi, 1986 (subsequent reprints), is a useful survey of geological information, and, unlike many other such publications, happily includes Pakistan and Bangladesh in its descriptions.

On ecological history at the global level, there is a useful text by Anthony N. Penna, *The Human Footprint—A Global Environmental History*, Malden, US, 2010 (paperback). There is also a well-reviewed book: Joachim Radkau, *Nature and Power: A Global History of the Environment*, Cambridge, 2008, also available in paperback. For human prehistory, with continuous reference to environmental conditions, one may consult Brian M. Fagan, *People of the Earth: An Introduction to World Prehistory*, 11th edn, Indian reprint, Delhi, 2004. But recent files of journals like *Antiquity* (UK), *Archaeology* (US) and *National Geographic* (US) for various parts of the world generally, and *Man and Environment* (Pune) for India, will be found most helpful for keeping one up-to-date on pre-Holocene ecology. On climate change during the Pleistocene, Yoshinori Yasuda and Vasant Shinde (eds), *Monsoon and Civilization*, New Delhi, 2004, is helpful as a work of reference, with much recent data furnished from India as well as China. The archaeological evidence for the period is studied in several contributions in Michael D. Petraglia and Bridget Allchin (eds), *The Evolution and History of Human Populations in South Asia*, Dordrecht, 2007. On Indian fauna, B.P. Sahu, *From Hunters to Breeders*, Delhi, 1987, Chapter IV, provides a summary of fossil evidence.

The Ice Age and Interglacial dates in Table 1.1 (Chronology) and the diagram in Figure 1.1 are based on graphs published by the *National Geographic*, to which thanks are due. Professor K. Padayya's estimate of population densities achieved in certain south Indian localities in Acheulian and Mesolithic times is given in an unpublished paper, 'Prehistoric Technology in India'.

Those interested in Ecology (the theme of our *Note 1.1*), will find in William Belée (ed.), *Advances in Historical Ecology*, New York, 1998, much relevant matter, though a certain bias is apparent. In S. Settar and Ravi Korisettar (eds), *Archaeology and Interactive Disciplines*, New Delhi, 2002, the bulk of the papers address different aspects of Indian ecology, with the studies mainly drawing upon archaeological finds.

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A People's History of India 36

MAN AND ENVIRONMENT

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